



# **UN/US Workshop on Use and Applications of Global Navigation Satellite Systems**

## **GPS Augmentation Status and Challenges of the Southern Hemisphere**

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Santiago, Chile**

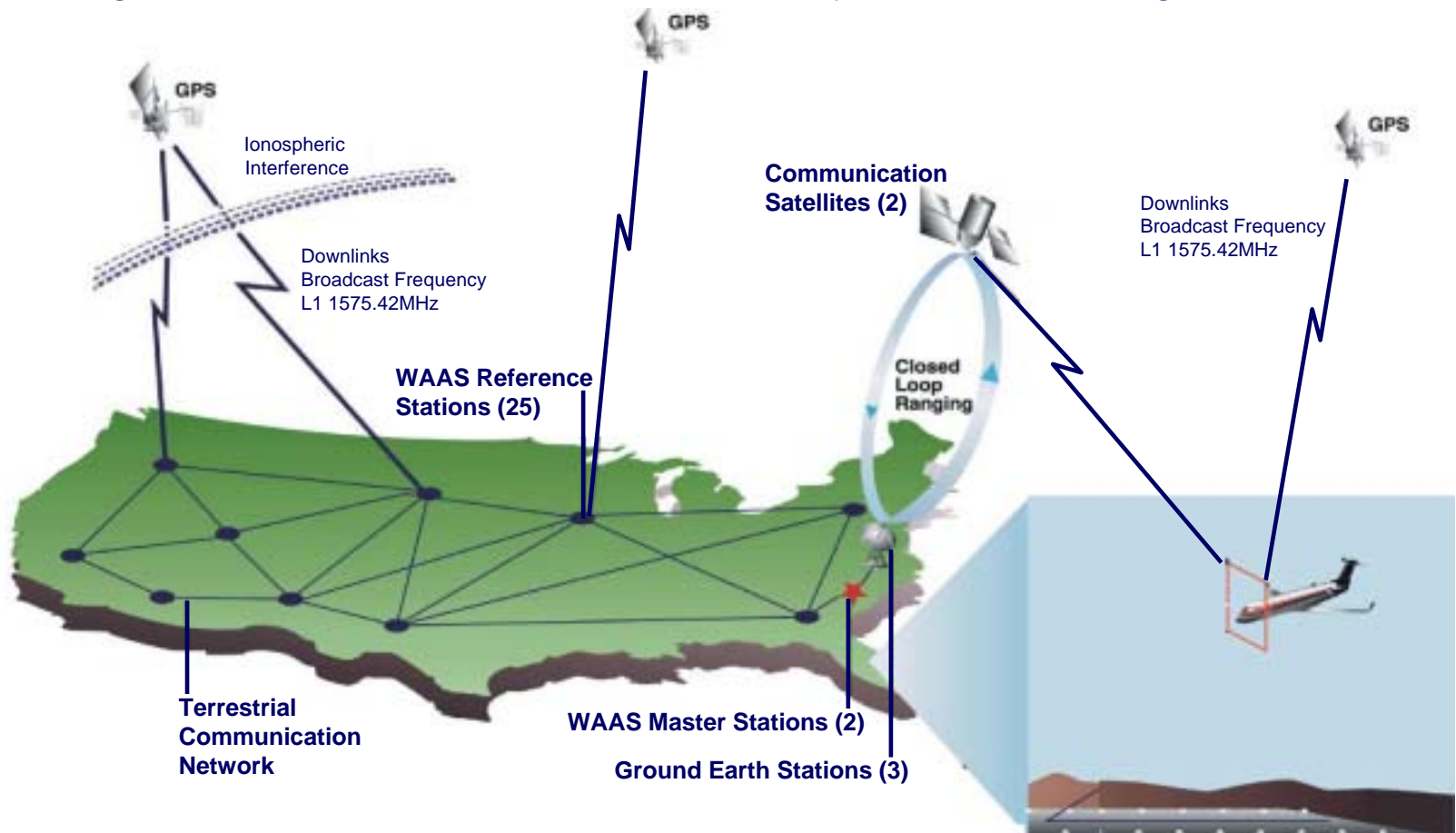


# Wide Area Augmentation System Architecture



All Elements in Place

Signal in Space Available for Non-Safety Uses Since August 2000





# WAAS Status



- Jan 97:** • **Two INMARSAT Geostationary (GEO) Satellites Leased**
  - FAA Lease Is For Communications Transponder on Commercial Satellite
  - AOR-W (Covers Eastern CONUS to Rocky Mountain Area)
  - POR (Covers Western CONUS, Alaska, Hawaii)
  
- Jun 98:** • **Hardware & Communications Installation Completed and Tested**
  - 25 WAAS Reference Stations (WRS)
  - 2 WAAS Master Stations (WMS)
  - 2 INMARSAT Satellites
  - 4 GEO Uplink Systems (GUS)
  - Terrestrial Communications Network
  
- Nov 99:** • **Software Development, Integration and Testing Completed**
  - Meets or Exceeds Accuracy and Availability Requirements



# WAAS Status



- Dec 99:** • **FAA Determined WAAS Did Not Meet  $10^{-7}$  Requirement**
  - In-Sufficient Analytical Proof
  - Integrity Verification Prevents IFR Aviation Use
  - Integrity Requirement Only Affects IFR Aviation Users
  
- Jan 00:** • **FAA Forms WAAS Integrity/Performance Panel (WIPP)**
  - Redesign Integrity Monitors And Revise System Safety Analysis To Insure Certification Approval
  
- Aug 00:** • **FAA Announcement that WAAS Signal-In-Space (SIS) Is Available To Public For Non-Safety Applications**
  - WAAS Operating 24/7 For Non-IFR Aviation and Other Users
  - Demonstrated Performance Better Than Specification
  - Since Aug 00, SIS Available 99.99%
  - Nominal Accuracy: 1 Meter Horizontal, 2 Meters Vertical



# **WAAS Development Initial Instrument Flight Rules (IFR)**



- **Plan Is To Complete Development Of Integrity Monitors and Complete System Testing For Acceptance By FAA In CY 03**
  - Goal is Acceptance Of System From Prime Contractor (Raytheon) In Mar 03 And
  - FAA Commissioning Of System By Dec 03
- **FAA Also Making Changes To Optimize System Maintainability By Airways Facilities**
  - Changes Will Not Impact Schedule For Contractor Acceptance
  - Human Factors Changes
  - Training Tools
- **Progress on Integrity Monitors Ahead of Schedule**
  - 8 Software Monitors Being Revised
  - All Operating on Signal-In-Space



# **WAAS Development Initial IFR**



- **Completion Of Integrity Monitor Integration Is Schedule Driver**
- **Initial Delivery Will Provide Service For All Phases Of Flight Down To LNAV/VNAV Approach Capability**
- **Will Provide IFR Service With Very Good Availability To Large Portions Of U.S. National Airspace System**
  - **Over More Than 90% Of CONUS**
  - **Portions Of Alaska And Caribbean**

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### ◆ Planned Completion



# **GEO Acquisition Strategy**



- **Near Term:**
  - **Provide A GEO Satellite On Orbit ASAP**
    - Mitigate Single Thread Failure of Existing INMARSAT-3 Constellation**
    - Improve Availability (Performance) And Coverage (Capability) Of Signal-In-Space To Users By Having More Optimized Orbital Locations**
    - Incorporate L5 Signal Capability for Increased Performance and Interference Mitigation**
    - Goal Is Satellite On Orbit By FY 04 To FY 05 Time Frame**
- **Long Term:**
  - **Provide Additional Replacement GEO Satellites On Orbit Prior to Expiration of Existing INMARSAT-3 Lease (End Of FY06)**
- **Aggressively Pursuing both Near and Long Term Solutions**





# WAAS Summary



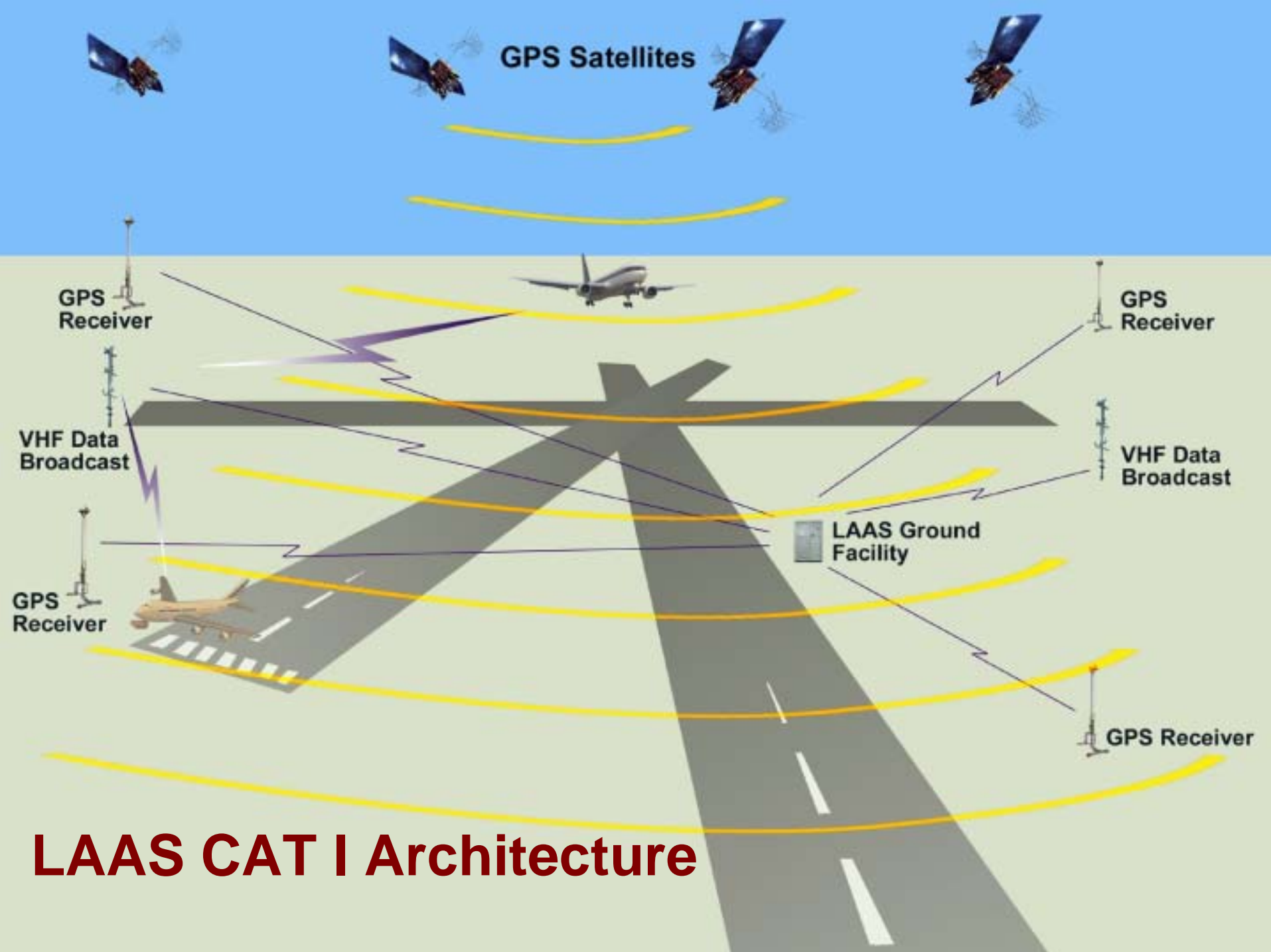
- **WAAS Is Being Developed Using An Incremental Strategy To Provide Benefits As They Become Available**
- **WAAS Hardware Is Fielded And Software Development Completed To Provide A Signal-In-Space**
- **System Is Broadcasting 24/7 And Is Providing A Robust And Reliable Signal-In-Space To A Variety Of Users**
- **Software Integrity Monitors And Safety Analyses Are Being Revised To Insure System Certification For IFR Use**
- **WAAS Prime Contract Development Is Ahead Of Schedule**
  - Contractor Acceptance Is Expected In Second Quarter Of FY 03
  - Commissioning Expected By Dec 03
- **GEO Satellite Acquisition Activities Underway**



# **Local Area Augmentation System (LAAS) Program Requirements**



- **CAT I Precision Landing Service**
  - Airports Where WAAS Coverage/Availability is Not Satisfactory
  - 46 Airports
- **CAT II/III Precision Landing Service**
  - Airports with Cat II/III ILS
  - New Qualifiers
  - 114 Airports
- **Requirements based on November 8, 1999 LAAS Requirements Document**
  - Being Updated to Reflect Current Requirements



# LAAS CAT I Architecture



# **LAAS**

## **Development/Acquisition**



- **Phase I**
  - **Government Industry Partnership (GIP) to Develop Non- Fed CAT I System Under FAA Type Acceptance (TA) Process, (Honeywell, Raytheon, Thales)**
- **Phase II**
  - **FAA Full-Scale Development (FSD) and Production of Fed CAT I Systems**
- **Phase III**
  - **FAA FSD and Production of Fed CAT II/III Systems**



# Current Status of GIP Efforts



- **Honeywell**
  - Honeywell LAAS CAT I Prototype Installed at Chicago O'Hare, Midway and Memphis
  - FedEx Flights against LAAS Prototype in O'Hare 10/01
- **Raytheon**
  - Raytheon LAAS CAT I Prototype at Salt Lake City
  - Interoperability Demonstration Holloman/JPALS and Salt Lake/LAAS Prototype Late August 2001
- **Airsys ATM/Thales**
  - Prototype Planned for New Century Airport/Kansas City



# **LAAS CAT I**

## **FAA Contract Schedule**



- **Request for Information (RFI) Released August 2001**
- **Release Draft Request for Offer (RFO) January 2002**
- **Release Final RFO March/April 2002**
- **Contract Award Planned July 2002**
- **Initial Operational Capability (IOC) Projected Dec 2004**



# LAAS Summary



- **Continuous Aviation User Support for LAAS**
- **LAAS Acquisition on Schedule**
  - Federal CAT I System Development on Contract in 2002 with IOC in CY 2004
- **Part 171 Private/Public Use Systems Expected in the NAS 1st Quarter 2003**



# Implementation Challenges



- Technically Understand the Capabilities
- Operationally Understand the Capabilities
- Identify Potential Barriers for Use (**Political, Institutional, Technical, Operational**)
- Develop a User Support Base: Educate and Involve in Solutions and Applications
- Identify Requirements
- Phased Implementation of GPS and Augmentations





# What Are the First Steps?



- **Schedule for and Complete WGS-84 Surveys**
- **Form Expertise Groups for Multiple Applications**
- **Develop Plans, Trials, Demonstrations (Regionally with ICAO as well as Within Each State)**
- **Identify Costs and Benefits (Are Your Plans a Good Investment?)**
- **Develop Needs and Requirements vs. Nice-to-Haves**
- **Identify Operational and Technical Solutions**



# Purpose of a Test Bed



- **Develop Technical Expertise in Satellite Navigation and Augmentation Technologies and Systems**
- **Establish State and Regional Requirements**
- **Ionosphere Research and Modeling**
- **Define a Cost-Effective Implementation and Ground Architecture**
- **Insure System Success and User Acceptance**
  - Address Critical Issues Involving the Use of GPS for Civil Aviation within State and Regional Airspace
- **Development of a Test Bed Should Be Progressive**
  - Proving Ground for System Feasibility
  - Address Operational Implementation Issues for GNSS



# ICAO Regional Project RLA/00/009 Overview



- **ICAO Regional Project for Latin America (RLA/00/009)**
  - Cooperative Effort Between ICAO's GREPECAS Member States with Assistance/Support from FAA
  - Establishes a GNSS Augmentation Test Bed (CSTB) Capability in Latin America That is Based on U.S. WAAS and LAAS Prototype Technology
  - CSTB Architecture Consists of Individual Test Bed Equipment Sets in Brazil and Chile, in Addition to FAA-Loaned Test Bed Equipment Sets in Argentina, Bolivia, Peru, Colombia, and Honduras
- **CSTB Architecture and Activity Timeline Approved August 2001**



# **ICAO Regional Project RLA/00/009 Objectives**



- **Assist the Region in Answering Many Questions Regarding GNSS Implementation and Operational Use**
  - Can GNSS Meet Existing Aviation Requirements?
  - How to Implement GNSS Economically and Efficiently?
  - What Unique Situations Will a Regional Augmentation System Have to Solve for (i.e., Ionosphere Effects)?
  - What Mix of GNSS Technologies Will be Needed?
  - What Will the Final System Architecture Look Like to Support Operational Uses and Meet all Requirements?
- **Support a Regional Transition to Operational GNSS Use in Latin America**
- **Create a Seamless GNSS Navigation Capability Throughout Latin American and Western Hemisphere**



# ICAO Regional Project RLA/00/009

## CSTB Architecture





# **ICAO Regional Project RLA/00/009 Status**



- Jun. 2001 RLA/00/009 Project Plan Approved by GREPECAS States**
- Oct. 2001 Brazil Test Bed (BTB), Consisting of 5 TRSs and 1 TMS, Installed and Operational**
- Oct. 2001 Brazil Ionosphere Data Collection Began**
- Jan. 2002 FAA Ionosphere Flight Tests, Brazil**





# **ICAO Regional Project RLA/00/009**

## **Status**



- March 2002    Complete Installation of all 5 CSTB TRSs  
– Argentina, Bolivia, Peru, Colombia and  
Honduras (COCESNA)**
- May-Dec 2002       Execution of Regional Test Plan**
- Mar-Dec 2003       Identify Specific Regional Plan &  
State Evaluations**
- Nov. 2003       GNSS Operational Requirements  
Training, Brazil**
- Mar-Dec 2004       Execution of State Test Plans**



# Summary



- **Worldwide Implementation of GPS and Its Augmentation Systems Continues to Grow**
- **ICAO Regional GNSS Implementation Projects Continue a Positive Momentum Towards a Global Architecture**
- **Safety, Efficiency, and Cost Savings Opportunities for all Worldwide Partners in This Effort**
- **Latin American States in conjunction with the FAA and ICAO, are working cooperatively to identify regional GNSS requirements and solutions**